April 23, 2014

Prepared for

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1 INTRODUCTION

The following report is provided as an amendment to the Bean Creek Westslope Cutthroat Trout Restoration Plan prepared by Confluence dated January 1, 2006. The site conditions and infrastructure have changed since the original plan was prepared. Confluence conducted a site visit and performed additional survey on August 15, 2013 to evaluate the current conditions and update the restoration plan accordingly.

Bean Creek is a small stream flowing north out of the Centennial Mountains in southwest Montana. The upper reaches of the stream flow through Bureau of Land Management (BLM) land before emerging into the agricultural land in the valley. Above the BLM boundary, the stream is in relatively pristine condition and supports a population of genetically pure westslope cutthroat trout believed to be isolated from other populations for as much as 10,000 years (Gazda pers comm). After leaving the forest, Bean Creek flows through a short reach with good habitat that supports cutthroat trout. However, the lower two miles of the creek have been significantly impacted by anthropogenic factors including channel straightening, overgrazing, removal of woody riparian vegetation, and ineffective irrigation infrastructure. This reach of Bean Creek offers little habitat for resident trout, and exhibits a fish passage barrier and a point source of sediment delivery to the channel.

Westslope cutthroat trout are currently a state species of special concern in Montana. They occupy less than 5% of their historic range and are primarily constrained to isolated headwater habitats (Sheppard et al 1997). Conserving and protecting these isolated populations may be critical in maintaining the long term survival of this species. Restoring natural characteristics of Bean Creek while improving detrimental infrastructure is an excellent opportunity to increase useable habitat for an isolated population of genetically pure westslope cutthroat trout. This report describes a restoration plan to reactivate historic meanders in a 900-foot channelized reach, improve riparian vegetation along this reach, reduce sedimentation from a county road, and replace dilapidated diversion structures with fish-friendly devices.

2 PROJECT LOCATION

The project is approximately 10 miles west of Lakeview in the Centennial Valley of southwestern Montana (Figure 1). The project lies entirely on private lands just north of public lands administered by the BLM.

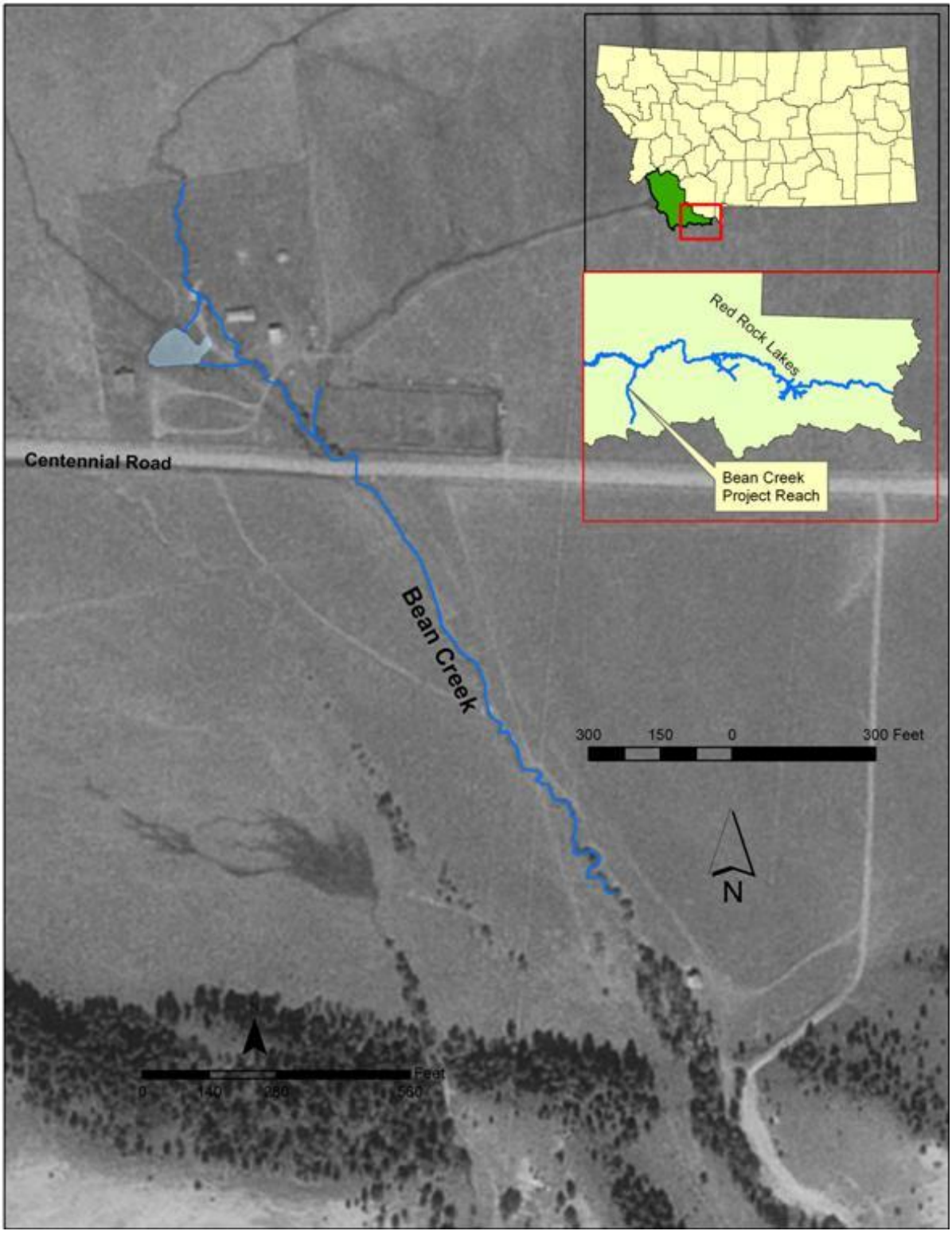

Figure 1. Location of Bean Creek Westslope Cutthroat Trout Restoration Project

3 EXISTING CONDITIONS

3.1 SOUTH OF COUNTY ROAD

Immediately upstream of the project site Bean Creek exists in a relatively pristine condition (Figure 2). In this reference reach the stream is a low width to depth ratio B3 channel (Rosgen 1996) with large cobble substrate. It is characterized as being moderately entrenched with irregular scour pools formed around a coarse cobble substrate. This channel type typically forms on coarse alluvial fans such as the one present where Bean Creek exits the Centennial Mountains. Riparian vegetation is abundant in the form of both woody (willow) species and herbaceous wetland species (rushes and sedges) immediately adjacent to the channel.

Figure 2. Reference reach.

South of the County Road, Bean Creek has been significantly impacted by anthropogenic factors including channel straightening, overgrazing, and removal of woody riparian vegetation (Figure 3). This section offers little habitat for resident trout and is uninhabitable in the winter due to ice formation. These impacts have resulted in a steep, over wide, shallow channel that lacks both deep water habitat and overhead cover. In the winter months the existing conditions promote the formation of frazil and anchor ice. By December, the creek commonly becomes jammed with ice and frozen solid to the stream bed. With no deep water habitat trout are unable to survive the winter in this reach.

Figure 3. Channelized Reach of Bean Creek. Note large cobble removed from the channel.

Where streams exit the mountains onto alluvial fans, the slope of the channel generally decreases as one travels downstream. In the case of Bean Creek, this trend is reversed due to the effects of channelization. The average slope of the reference reach is 0.029 ft/ft (Figure 4) while the slope is the channelized section averages 0.032 ft/ft (Figure 4). The sinuosity of the reference reach is 1.4, while the existing sinuosity of the restoration reach is 1.0. Additional evidence suggests large cobbles, which comprise Bean Creek's main habitat forming feature, were removed from the stream during channelization.

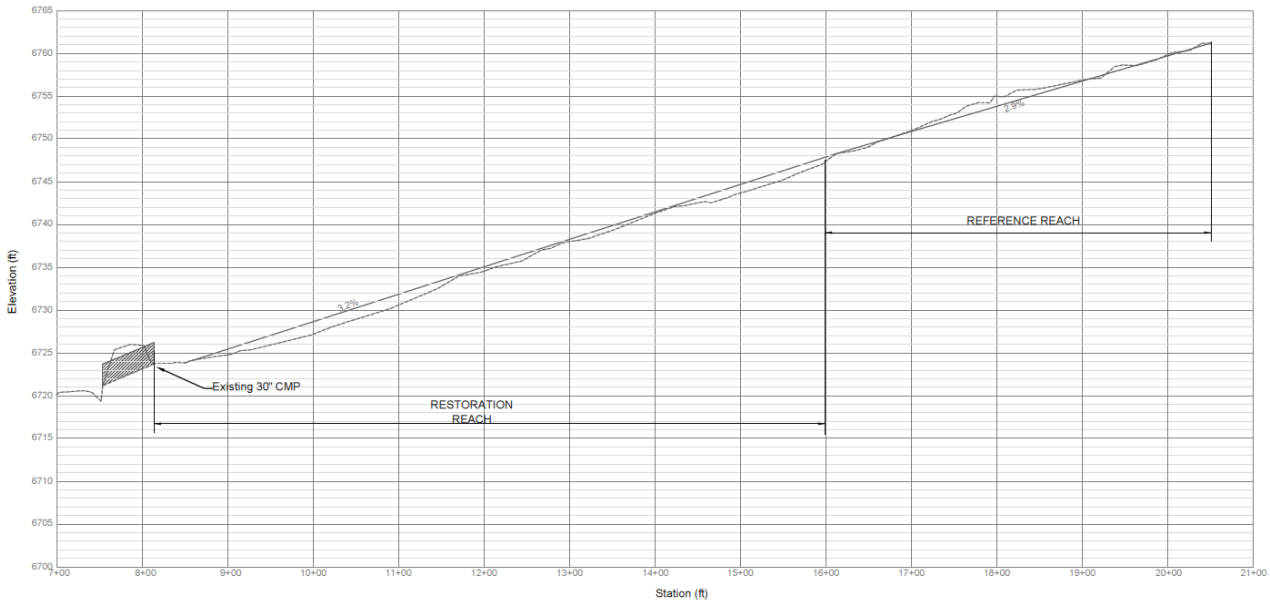

Figure 4. Existing Reach Upstream of Road.

3.2 NORTH OF COUNTY ROAD

Downstream of the channelized reach, Bean Creek flows through private lands currently utilized for agricultural operations. The creek flows diagonally across the county road via a 36" corrugated metal culvert. An irrigation diversion, currently controlled by tarps, is located immediately downstream of the road. Downstream of the diversion, Bean Creek's flows are split between a natural channel and a pond. The pond has a degraded 12" gate inlet structure, also due to frost heaving causing water to flow underneath the structure.

Figure 5. Irrigation Diversion with tarp.

During the winter months, icing occurs immediately downstream of the road and poses a potential threat to the existing structures.

4 RESTORATION PLAN

4.1 REACTIVATE HISTORIC MEANDERS SOUTH OF COUNTY ROAD

Several historic meanders are evident along Bean Creek on the southern portion of the project reach (Figure 6). These meanders were isolated with berms when the stream was straightened. While the historic channel has grown in to some extent, it still exhibits similar form to the surveyed reference reach. The historic meanders will exhibit similar characteristics when they are reconnected with the stream.

Cross sections in the reference reach immediately upstream of the project site were surveyed to determine design channel dimensions. At-a-station hydraulics calculations were performed and

base flow and bankfull discharges were calculated based on surveyed water surfaces and field observed bankfull indicators. Table 1 provides results for the survey and hydraulic analysis.

Table 1. Bean Creek relocation parameters.

Reach	XS	Type	Area (ft^2)	W - Top Width (ft)	D_{max} (ft)	D_{mean} (ft)	W/D	Base Flow (ft^3/s)	Bankfull Discharge (ft^3/s)
Reference	14	Riffle	4.93	5.11	1.40	0.96	5.30	4.00	26
Reference	15	Riffle	4.16	5.61	0.88	0.74	7.57	2.5	19
Reference	16	Riffle	5.4	6.65	1.50	0.81	8.19	1.80	27.50
Aveage:			**4.83**	**5.79**	**1.26**	**0.84**	**7.02**	**2.77**	**24.17**

Figure 7 shows a typical section of Bean Creek where historic meanders were cut off during channelization of the stream. The existing channel is overwide and was excavated to an elevation slightly lower than the historic channel bed. A constructed berm separates the current and historic channels through much of the reach. Reactivating the historic meander will involve salvaging larger cobble from the existing stream bed for use in habitat creation and regrading the berm. Construction of pool habitat and revegetation of riparian areas will be included with the channel relocation and are described in the following sections.

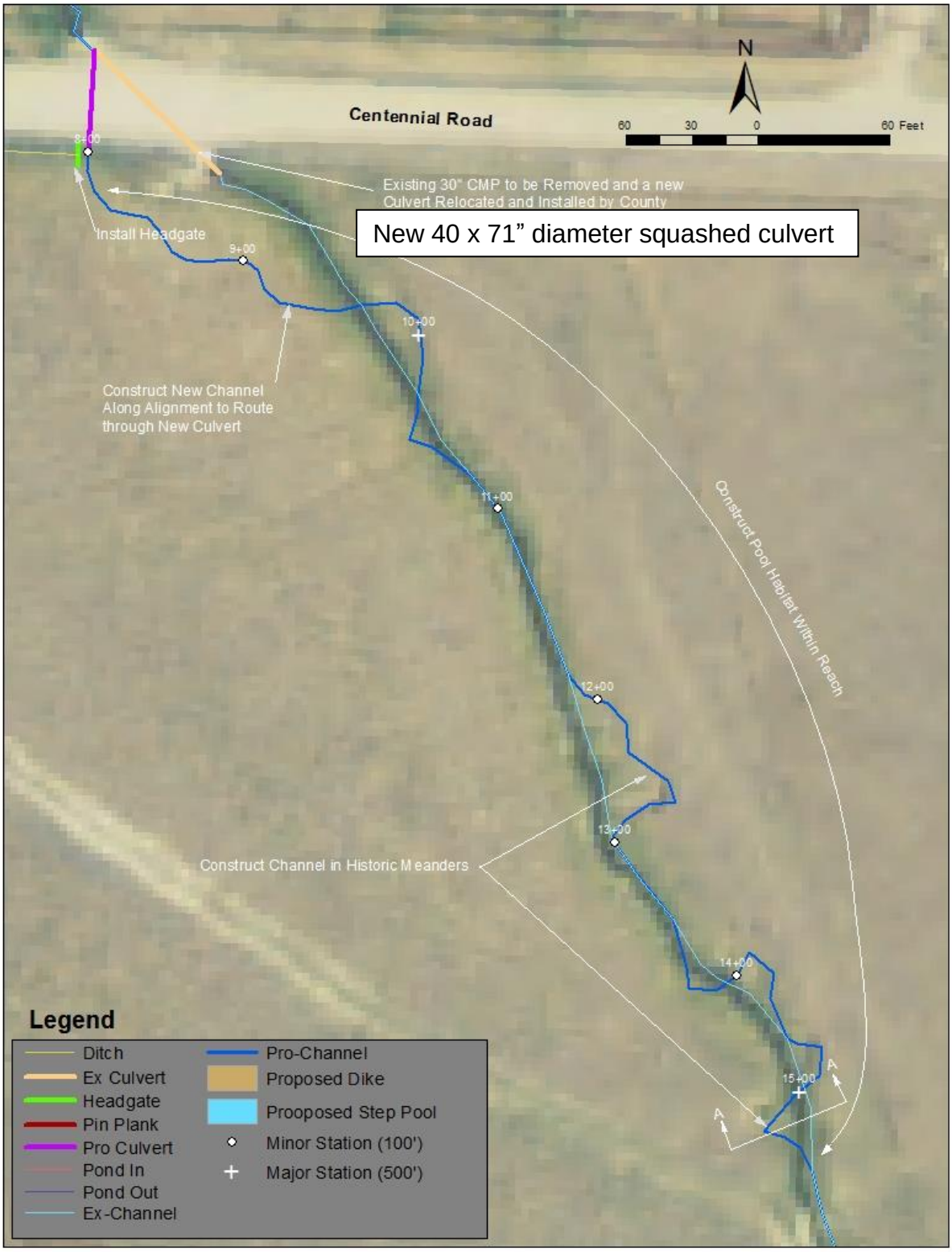

Figure 6. Plan View of Bean Creek on the South Side of Centennial Road.

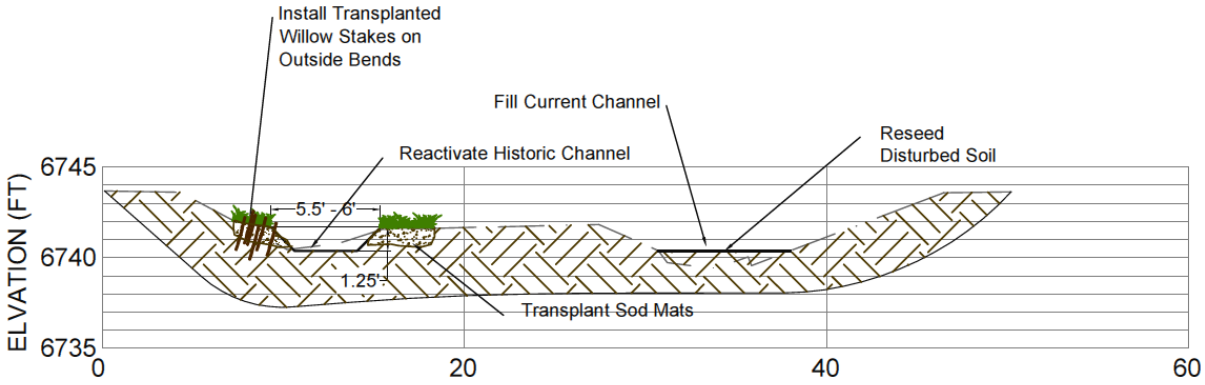

Figure 7. Design cross section showing historic meander reactivation.

By relocating the stream into its historic configuration, slope will be decreased from 0.032 ft/ft to 0.025 ft/ft (Figure 8) and sinuosity will be increased from 1.0 to 1.3. The slope and sinuosity of the restored reach closely match reference conditions and will result in improved habitat and a properly functioning riparian community.

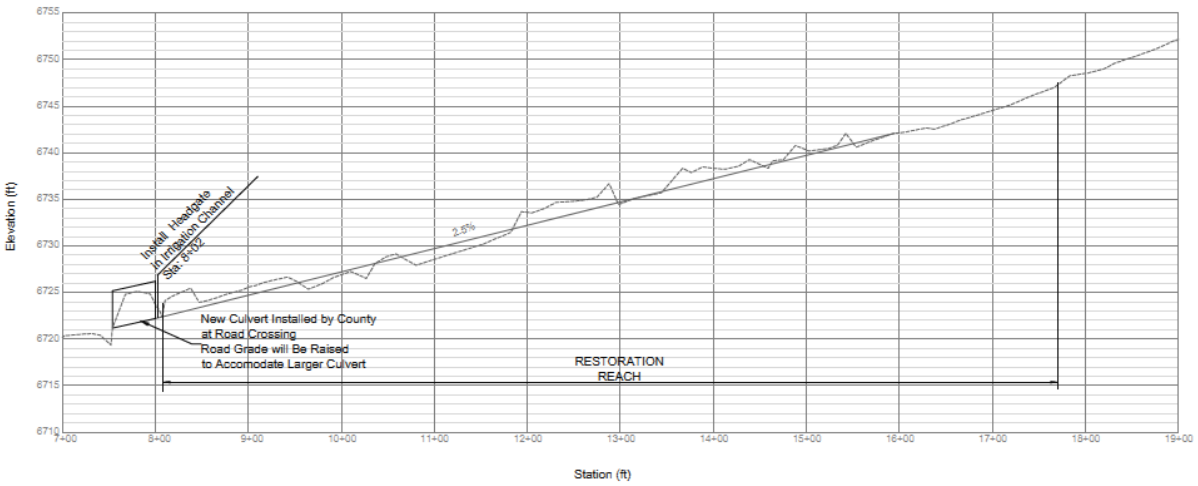

Figure 8. Longitudinal Profile with reactivated meanders.

Immediately upstream of the county road, the channel will be relocated to align with the location of the proposed culvert. The new culvert will be installed perpendicular to the road to reduce culvert length, improve fish passage and reduce the potential for ice jams. The realignment of the culvert and channel will also reduce potential for sediment input from road grading and plowing. The realigned channel upstream of the road will be constructed within a topographic depression to reduce excavation.

4.2 CONSTRUCT & IMPROVE POOL HABITAT

A reference reach approach determined appropriate and sustainable pool types and dimensions for the discharge and channel characteristics of Bean Creek. Typical of B3 channels on course alluvial fans, the majority of the pools in the reference reach are rock scour, backwater, and step pools (Figure 9) spaced every 3 to 5 bankfull channel widths (Wbf ~ 6 feet). Bankfull pool depths range from 1.25 to 2 feet. Large rocks are common in this reach of Bean Creek and are the main formative feature associated with pools. When Bean Creek was channelized, these large rocks were removed and the channel widened. The proposed restoration aims to utilize the available rock to construct pool supporting structures. Rock placement will be determined based on observation of existing habitat forming features in the reference reach. Pools will be constructed every 3 to 5 channel widths resulting in approximately 30 new pools.

Figure 9. Reference Reach Pool Habitat

4.3 RESTORE RIPARIAN VEGETATION

All banks throughout the newly activated channel reach will be resodded using local sod transplant sources. Outside meander bends will be sprigged with willow stakes native to the project reach. The U.S. Fish and Wildlife service has secured a source of willow sprigs on the Red Rock Lakes Wildlife Refuge for use in establishing woody vegetation along newly activated meanders. All areas disturbed by channel reactivation will be reseeded with a customized native vegetation seed mix.

4.4 REPLACE AND RELOCATE COUNTY ROAD CULVERT

Bean Creek flows through a culvert diagonally under the Centennial Road (**Error! Reference source not found.**). The existing culvert is going to be replaced with a larger culvert to provide additional capacity and reduce ice flows during the winter months. The culvert will be relocated and oriented perpendicular to the road as shown in the plan view (**Error! Reference source not found.**). The culvert replacement work will be funded and conducted by the County Road and Bridge Department.

4.5 INSTALL IRRIGATION HEADGATE

A headgate will be installed at the upstream end of the relocated culvert crossing Centennial Road to provide water to the irrigation ditch on the south side of the road (**Error! Reference source not found.**).

4.6 BENEFITS

Restoring the channelized portion of Bean Creek will provide an isolated population of genetically pure westslope cutthroat trout with over 800 feet of excellent additional habitat. Creating a flatter, narrower and deeper channel with abundant pool habitat will provide trout with essential winter habitat and potentially result in less ice buildup at the county road crossing.

The new headgate will seal water from flowing down the ditch during winter months, eliminating a potential source ice formation and keeping winter flows in the Bean Creek channel.

5 COSTS

Anticipated costs to implement the restoration designs are presented in Table 2. Costs were estimated using unit prices from similar projects and include heavy equipment, labor, materials, project management, construction oversight, travel, and per diem expenses.

Table 2: Bean Creek Restoration cost estimate.

Cost Estimate for Bean Creek Restoration Project

Task No.	Work Items	Qty	Unit	Unit Costs	Total Cost
USFWS Funded Project Components					
1	**Project Management and Oversight**				
1.1	Communication, logistics, scheduling	6	hr	$95	$570.00
1.2	Contracting, invoicing, and budget tracking	4	ea	$95	$380.00
1.3	Mileage	1260	mi	$0.57	$718.20
1.4	Per Diem	6	da	$129	$774.00
1.5	Construction Oversight	55	hr	$95	$5,225.00
				Subtotal:	*$7,667.20*
2	**Construction**				
2.1	Mobilization	1	ea	$800	$800.00
2.2	**Channel Restoration Upstream of Road**				
2.2.a	Restore Channel (Relocate channel to new culvert alignment, activate meanders, install sod mats/willows, fill existing channel)	40	hr	$125	$5,000.00
2.2.b	Construct 30 Pools Above Road	15	hr	$125	$1,875.00
2.2.c	Install Willows (1/foot for 950 feet of channel)	950	qty	$2	$1,900.00
				Subtotal:	*$9,575.00*
2.4	**Irrigation Ditch Diversion Upstream of Road**				
2.4.a	Install Waterman Headgate	2	hr	$125	$250.00
2.4.b	Material Costs for Headgate	1	ea	$500	$500.00
				Subtotal:	*$750.00*
				USFWS Total:	***$17,992.20***

6 SCHEDULE

Construction on Bean Creek will occur in late summer or early fall to take advantage of favorable construction conditions (low water and fair weather) and to avoid the spawning of resident cutthroat trout.

7 REFERENCES

Gazda, R. personal comments from Bean Creek site visit.

Rosgen, Dave. 1996. Applied Geomorphology. Wildland Hydrology, Pagosa Springs, Colorado.

Sheppard, B. B., B. Sanborn, L. Ulmer, and D. Lee. 1997. Status and Risk of Extinction for Westslope Cutthroat Trout in the Upper Missouri River Basin, Montana. North American Journal of Fisheries Management (17) 1158-1172. Copyright by the American Fisheries Society